

INTERVENTIONAL CARDIOLOGY AND SURGERY

Predictive value of EuroSCORE on long term outcome in cardiac surgery patients: a single institution study

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Objectives: To assess the value of the European system for cardiac operative risk evaluation (EuroSCORE), a validated model for prediction of in-hospital mortality after cardiac surgery, in predicting long term event-free survival.

Design and setting: Single institution observational cohort study.

Patients: Adult patients (n = 1230) who underwent cardiac surgery between January 2000 and August 2002.

Results: Mean age was 65 (11) years and 32% were women. Type of surgery was isolated coronary artery bypass grafting in 62%, valve surgery in 23%, surgery on the thoracic aorta in 4%, and combined or other procedures in 11%. Mean EuroSCORE was 4.53 (3.16) (range 0-21); 366 were in the low (0-2), 442 in the medium (3-5), 288 in the high (6-8), and 134 in the very high risk group (≥ 9). Information on deaths or events leading to hospital admission after the index discharge was obtained from the Regional Health Database. Out of hospital deaths were identified through the National Death Index. In-hospital 30 day mortality was 2.8% (n = 34). During 2024 person-years of follow up, 44 of 1196 patients discharged alive (3.7%) died. By Cox multivariate analysis, EuroSCORE was the single best independent predictor of long term all cause mortality (hazard ratio (HR) 1.55, 95% confidence interval (CI) 1.03 to 2.34, $p < 0.0001$). In the time to first event analysis, 227 either died without previous events (n = 20, 9%) or were admitted to hospital for an event (n = 207, 91%). EuroSCORE (HR 1.60, 95% CI 1.36 to 1.89, $p < 0.0001$), the presence of ≥ 2 co-morbidities versus one (HR 1.49, 95% CI 1.09 to 2.02, $p < 0.0001$), and > 96 hours' stay in the intensive care unit after surgery (HR 2.04, 95% CI 1.42 to 2.95, $p = 0.0001$) were independently associated with the combined end point of death or hospital admission after the index discharge.

Conclusions: EuroSCORE and a prolonged intensive care stay after surgery are associated with long term event-free survival and can be used to tailor long term postoperative follow up and plan resource allocation for the cardiac surgical patient.

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The European system for cardiac operative risk evaluation (EuroSCORE) was developed between 1995 and 1999 to provide a simple, additive risk model of perioperative mortality^{1,2} in over 19 000 consecutive adult patients undergoing open heart surgery in 128 centres in eight European countries. EuroSCORE has been further evaluated in two cohorts (1995 and 1998-1999) from the Society of Thoracic Surgeons' North American database in over 500 000 patients.³ EuroSCORE predicted with good accuracy in-hospital or 30 day mortality in both the European and US cohorts, regardless of baseline between-country differences. Furthermore, despite relevant differences in patient demographics and type of surgery within the European Union, EuroSCORE performance in the single participating countries varied from good to excellent.⁴

The assessment of long term outcome after cardiac surgery according to preprocedural risk may also be important to enhance continuity of care and to plan resource allocation appropriately for the postsurgical cardiac patient. Our goal was to determine whether EuroSCORE is a useful predictor of the long term hazard of cardiovascular events leading to death or hospital admissions after cardiac surgery.

METHODS

All adult patients who were resident in our region and underwent cardiac surgery at our institution between January 2000 and August 2002 (n = 1230) were enrolled in the study. Detailed data were collected on the index

admission, when cardiac surgery was performed, and the EuroSCORE calculated according to the standard additive method.² In-hospital mortality was defined as death within 30 days of operation or within the same hospital admission. Follow up data were derived from the Regional Health Database, which includes all hospital discharges, accessed with the Regional Health System number. Subsequent hospital admissions were coded according to the principal or additional diagnoses (disease classification according to the *International classification of diseases*, 9th revision, clinical modification) and related procedures. Out of hospital deaths were identified through the National Death Index.

Statistical analysis

Continuous variables were expressed as mean (SD) or median (interquartile range). Univariate analyses were performed by Student's *t* test or one way analysis of variance. Bonferroni correction was used for multiple comparisons. Discrete variables were summarised by frequency percentages and analysed by χ^2 test.

Time to death and time to first event for the combined end point (death or first hospital admission for cardiovascular reasons) were studied as a function of covariates with a Cox proportional hazards model. Relevant covariates were

Abbreviations: CABG, coronary artery bypass grafting; CI, confidence interval; DRG, diagnosis related group; EuroSCORE, European system for cardiac operative risk evaluation; HR, hazard ratio; ICU, intensive care unit

selected through a backward selection procedure and the Akaike Information Criterion (AIC). Proportionality of hazards was checked with the Grambsch-Therneau test and diagnostic plots based on Schoenfeld residuals. Non-linear effect of covariates was modelled with a restricted cubic spline function, assessed by a χ^2 Wald test.⁵ The model was validated by bootstrap (200 runs) adjusted by the degree of optimism in bootstrap estimates. Computed indexes were the Somer's Dxy (the closer to 1 in absolute value, the better), the discrimination index D (the higher, the better), the unreliability index U (the closer to 0, the better), the overall quality index Q (the higher, the better), and the slope index (the closer to 1, the better).

EuroSCORE was assessed as a continuous variable and was furthermore classified, for descriptive purposes, into four risk categories: low (0–2, *n* = 366), medium (3–5, *n* = 442), high (6–8, *n* = 288), and very high risk groups (≥ 9 , *n* = 134).

Patient-level costs were assessed in two ways. Firstly, hospital specific costs, derived with a top down procedure, were attributed to each day of stay in different medical, surgical, or rehabilitative wards or in the intensive care unit (ICU). Secondly, the patient-level global costs of all hospital admissions after the index discharge were calculated as the sum of diagnosis related group (DRG) tariffs—that is, the reimbursement to the institution for the DRG produced by each admission.

A probability value of *p* < 0.05 was considered significant. All analyses were performed with the S-PLUS (S-PLUS 2000, MathSoft, Seattle, Washington, USA).

RESULTS

Study population

In the 1230 patient series, mean (SD) age was 65 (11) and 32% were women. EuroSCORE averaged 4.53 (3.16) (range 0–21) in the whole series and 1.22 (0.82) in the low, 3.93 (0.81) in the medium, 6.72 (0.79) in the high, and 10.85 (2.24) in the very high risk groups.

Chronic heart failure was present in 33 (2.7%) of patients and atrial fibrillation in 8.7%. Left ventricular ejection fraction was 55 (10%); it was normal (≥ 0.50) in 77% of patients, moderately depressed (0.30–0.50%) in 21%, and poor (< 0.30%) in 2%.

Previous cardiac surgery had been carried out in 55 (4.4%) patients. Surgery was elective in 94% of procedures, was urgent in 5%, and was performed in a critical preoperative state in 1%. Emergency surgery for catheter laboratory complications accounted for 0.6% of all procedures.

Isolated coronary artery bypass grafting (CABG) was performed in 62% of patients; 79% of them had on-pump surgery and 21% had an off-pump procedure, most commonly (15%) minimally invasive surgery. One third of patients had three or more distal anastomoses, 48% had two, and 19% had one. An arterial graft consisting of the left internal mammary artery was implanted in 98% of patients. CABG was combined with other surgery in 124 further patients.

Valve procedures alone were performed in 23% of patients, of which 81% were on a single valve, 16% on two valves, and 3% on three valves. Valve surgery was combined with other surgery in 101 further patients. There were 234 operations on the aortic, 215 on the mitral, and 31 on the tricuspid valves. In seven patients, surgery was performed because of a malfunctioning mechanical prosthesis (1.6%). Active endocarditis was present in 1.1% of all patients who underwent valve surgery.

Surgery on the thoracic aorta accounted for 4% and atrial septal defect repair for 0.5% of all procedures.

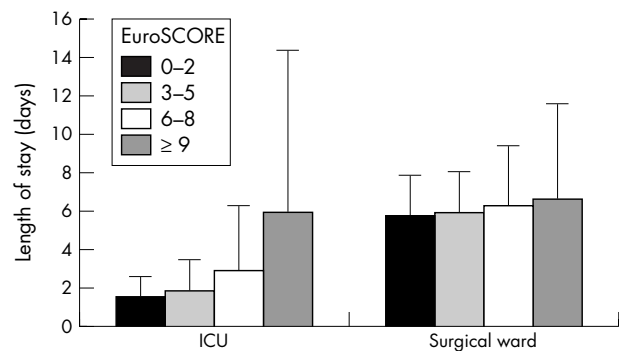


Figure 1 Length of stay according to the European system for cardiac operative risk evaluation (EuroSCORE) risk group in the intensive care unit (ICU) (*p* < 0.0001 very high versus high, medium, and low risk groups and high versus medium and low risk groups) or in the surgical ward after ICU discharge (*p* < 0.01 very high versus low risk group). Data are mean (SD).

In-hospital outcome

After surgery, patients remained on average 2.45 (3.67) days (median one day) in the ICU and 6.05 (2.81) days (median six days) in the surgical ward. Length of stay was significantly different according to EuroSCORE risk group (fig 1). Ninety eight (8%) patients remained more than 96 hours in the ICU (average stay 10.9 (8.9) days).

During the index admission, 34 patients died (total in-hospital or 30 day mortality of 2.8%). Mortality rates were 0.8% in the low, 1.1% in the medium, 4.5% in the high, and 9.7% in the very high risk groups (*p* < 0.0001).

Long term outcome

During 2024 person-years of follow up (median 20 (inter-quartile range 12–29), mean (SD) 20 (9) months), 44 of 1196 patients discharged alive died of any cause (3.7%) (table 1). The combined end point of death or hospital admission for a cardiovascular event was reached by 227 patients and 969 were alive and free of events at the end of the study (table 2).

Death as the first event occurred in 20 patients and 24 died in the course of a hospital admission for a cardiovascular event. We observed 307 events in 207 patients; the most frequent causes of unplanned hospital admissions during follow up (*n* = 283) were heart failure (29%) and acute coronary syndromes (22%), followed by cerebrovascular events (transient ischaemic attack, stroke, 17%), arrhythmias (15%), peripheral vascular complications (10%), and other (7%).

Predictors of outcome

In the 1196 patients discharged alive after surgery, EuroSCORE was the single best independent predictor of all cause mortality (table 3). The risk of death increased continuously with EuroSCORE (fig 2). The area under the receiver operating characteristic curve was 0.71 with 95% CI 0.63 to 0.79.

The independent predictors of the combined end point of death or hospital admission after the index discharge were a high EuroSCORE, the presence of two or more co-morbidities, and > 96 hours' ICU stay after the surgical procedure (table 3). The adjusted risk of death or hospital admission increased continuously with EuroSCORE (fig 2). The increase in risk was steeper for EuroSCORE values between 2 and 4 but the decrement in risk was not significant below 2. The area under the receiver operating characteristic curve was 0.71, with 95% CI 0.68 to 0.73.

Table 1 Main characteristics of the study population with hazard ratio (HR) of death after index discharge by univariate analysis

	All patients (n = 1196)	Alive (n = 1152)	Dead (n = 44)	HR	95% CI
Age (years)	67 (59–73)	67 (59–73)	72 (64–77)	2.55	1.51 to 4.33
EuroSCORE	4 (2–6)	4 (2–6)	7 (3–9)	2.37	1.80 to 3.12
LVEF (%)	56 (50–62)	56 (50–63)	53 (40–55)	0.58	0.42 to 0.79
Women	379 (32%)	364 (32%)	15 (34%)	1.10	0.89 to 2.06
Married	862 (72%)	837 (73%)	25 (57%)	0.51	0.28 to 0.93
Currently working	245 (20%)	240 (21%)	5 (11%)	0.49	0.19 to 1.25
Number of co-morbidities					
0	373 (31%)	369 (32%)	4 (9%)	0.34	0.11 to 1.04
1	436 (37%)	422 (32%)	14 (32%)	1	NA
≥2	387 (32%)	361 (31%)	26 (59%)	2.13	1.11 to 4.08
Primary cardiac diagnosis					
Coronary artery disease	807 (67%)	780 (68%)	27 (61%)	1	NA
Valvar	352 (30%)	336 (29%)	17 (39%)	1.49	0.81 to 2.73
Other	15 (1%)	15 (1%)	0		
Aortic aneurysm	21 (2%)	21 (2%)	0		
Hypertension	611 (51%)	584 (51%)	27 (61%)	1.51	0.82 to 2.77
Diabetes	231 (19%)	218 (19%)	13 (29%)	1.71	0.89 to 3.26
Peripheral arteriopathy	140 (12%)	128 (11%)	12 (27%)	2.71	1.40 to 5.26
Cerebrovascular disease	123 (10%)	117 (10%)	6 (14%)	1.61	0.68 to 3.81
Chronic kidney dysfunction	72 (6%)	67 (6%)	5 (11%)	2.27	0.89 to 5.76
Chronic pulmonary disease	166 (14%)	160 (14%)	6 (14%)	0.91	0.38 to 2.15
Previous AMI	409 (34%)	391 (34%)	18 (41%)	1.30	0.71 to 2.37
Thyroid disease	37 (3%)	35 (3%)	2 (4%)	1.65	0.40 to 6.78
Gastroenteric disorders	149 (12%)	141 (12%)	8 (18%)	1.58	0.73 to 3.39
Pulmonary hypertension	52 (4%)	47 (4%)	5 (11%)	2.67	1.05 to 6.68
Neoplasms	15 (1%)	11 (1%)	4 (9%)	8.50	3.04 to 24
AMI in preceding three months	133 (11%)	127 (11%)	6 (14%)	1.30	0.55 to 3.08
Previous cardiac surgery	54 (5%)	53 (5%)	1 (2%)	0.47	0.07 to 3.33
Status at surgery					
Not urgent	1131 (95%)	1092 (95%)	39 (89%)	1	NA
Urgent	52 (4%)	48 (4%)	4 (9%)	2.40	0.86 to 6.73
Critical	13 (1%)	12 (1%)	1 (2%)	2.00	0.27 to 14.58
Type of surgical procedure					
Coronary bypass grafting	747 (62%)	724 (63%)	23 (52%)	1	NA
Valve repair or replacement	270 (23%)	258 (22%)	12 (27%)	1.48	0.74 to 2.98
Combined or other procedure	138 (12%)	129 (11%)	9 (21%)	2.17	1.00 to 4.69
Surgery on thoracic aorta	41 (3%)	41 (4%)	0		
ICU stay >96 hours	87 (7%)	76 (7%)	11 (25%)	4.60	2.33 to 9.11
Postsurgical LOS ≥9 days	413 (34%)	391 (34%)	22 (50%)	1.89	1.05 to 3.45
Postoperative rehabilitation	897 (75%)	866 (75%)	31 (70%)	0.85	0.44 to 1.62

Data are median (interquartile range) or number (%).

AMI, acute myocardial infarction; CI, confidence interval; EuroSCORE, European system for cardiac operative risk evaluation; ICU, intensive care unit; LOS, length of stay; LVEF, left ventricular ejection fraction; NA, not applicable.

Patient-level costs

All in-hospital costs, assessed separately for the index admission, for total follow up based on the length of stay in various wards and for the total DRG value of hospital admissions after the index discharge tended to increase with increasing EuroSCORE. Total follow up cost for patients in the highest risk EuroSCORE group was almost double that of the low risk group (fig 3).

DISCUSSION

This study was performed at the beginning of the 21st century, at a time when many innovations have taken place in cardiac surgery. Patients were enrolled at a single institution during a relatively short period of time, so that the surgical procedures may be considered standardised and homogeneous. We showed that, in patients discharged alive after cardiac surgery, EuroSCORE is associated with the long term risk of death and of a combined end point of death or hospital admission for a cardiovascular event. Other predictors of the combined end point were the presence of two or more co-morbid conditions and > 96 hours spent in the ICU after the surgical procedure.

Cardiac surgery progressed enormously during the past decade and an ever increasing number of elderly, severely ill patients are undergoing complex and often life saving procedures. Standardised risk stratification is a core issue to

ensure high quality surgery. EuroSCORE is a scoring system devised to provide knowledge of operative risk and comparative outcomes of cardiac surgery. However, operative mortality is not the only important outcome measure: patients who survive cardiac operations may still have high morbidity and a poor long term outcome.⁶ Although high risk patients have the greatest absolute benefit from cardiac surgery and encouraging results from long term survival analyses have been reported in large scale registries,^{7,8} relating long term mortality and hospital admission for cardiovascular events to risk is important beyond immediate results, to tailor follow up care to the individual patient's needs. A long term outcome perspective based on the global preoperative risk of these patients may add to continuity of care and appropriate planning of resource allocation.

Our institution is a private accredited facility without an emergency department for outpatients at the time of patient enrolment; this may explain why our study population is partly different from the original EuroSCORE derivation set. Surgery was largely elective and few patients had severely impaired ventricular function, yet mean age and female prevalence were higher and surgery on thoracic aorta was more common than those reported for the whole European series. As net result of these factors weighing in opposite directions, average EuroSCOREs were similar to our national cohort data in the original derivation set.⁴ In-hospital

Table 2 Main characteristics of the study population with HR of events or death after index discharge by univariate analysis

	All patients (n = 1196)	No event (n = 969)	Event or death (n = 227)	HR	95% CI
Age (years)	67 (59–73)	66 (58–73)	70 (63–76)	1.64	1.34 to 2.01
EuroSCORE	4 (2–6)	4 (2–6)	6 (3–8)	1.96	1.69 to 2.27
LVEF (%)	56 (50–62)	56 (50–63)	55 (45–61)	0.71	0.62 to 0.83
Women	379 (32%)	297 (31%)	82 (36%)	1.24	0.94 to 1.62
Married	862 (72%)	713 (74%)	149 (66%)	0.72	0.55 to 0.95
Currently working	245 (20%)	214 (22%)	31 (14%)	0.59	0.40 to 0.86
Number of co-morbidities					
0	373 (31%)	334 (34%)	39 (17%)	0.62	0.42 to 0.92
1	436 (37%)	363 (38%)	73 (32%)	1	NA
≥2	387 (32%)	272 (28%)	115 (51%)	1.95	1.46 to 2.62
Primary cardiac diagnosis					
Coronary artery disease	807 (67%)	661 (68%)	146 (64%)	1	NA
Valvar	352 (30%)	275 (28%)	78 (34%)	1.25	0.95 to 1.62
Other	15 (1%)	14 (1%)	1 (<1%)	0.31	0.04 to 2.21
Aortic aneurysm	21 (2%)	19 (2%)	2 (1%)	0.48	0.12 to 1.95
Hypertension	611 (51%)	493 (51%)	118 (52%)	1.02	0.79 to 1.33
Diabetes	231 (19%)	165 (17%)	66 (29%)	1.80	1.35 to 2.40
Peripheral arteriopathy	140 (12%)	89 (9%)	51 (22%)	2.47	1.81 to 3.37
Cerebrovascular disease	123 (10%)	88 (9%)	35 (15%)	1.92	1.38 to 2.84
Chronic kidney dysfunction	72 (6%)	47 (5%)	25 (11%)	2.32	1.53 to 3.52
Chronic pulmonary disease	166 (14%)	121 (12%)	45 (20%)	1.51	1.09 to 2.09
Previous AMI	409 (34%)	321 (33%)	88 (39%)	1.22	0.93 to 1.59
Thyroid disease	37 (3%)	28 (3%)	9 (4%)	1.41	0.72 to 2.75
Gastroenteric disorders	149 (12%)	118 (12%)	31 (14%)	1.09	0.75 to 1.60
Pulmonary hypertension	52 (4%)	37 (4%)	15 (7%)	1.55	0.92 to 2.61
Neoplasms	15 (1%)	7 (1%)	8 (3%)	3.31	1.63 to 6.69
AMI in preceding three months	133 (11%)	101 (10%)	32 (14%)	1.41	0.97 to 2.05
Previous cardiac surgery	54 (5%)	44 (5%)	10 (5%)	0.89	0.47 to 1.67
Status at surgery					
Not urgent	1131 (95%)	922 (95%)	209 (92%)	0.63	0.37 to 1.09
Urgent	52 (4%)	38 (4%)	14 (6%)	1	NA
Critical	13 (1%)	9 (1%)	4 (2%)	1.04	0.34 to 3.20
Type of surgical procedure					
Coronary bypass grafting	747 (62%)	621 (64%)	126 (55%)	1	NA
Valve repair or replacement	270 (23%)	212 (22%)	58 (26%)	1.89	1.33 to 2.69
Combined or other procedure	138 (12%)	97 (10%)	41 (18%)	1.27	0.59 to 2.71
Surgery on thoracic aorta	41 (3%)	39 (4%)	3 (1%)	0.30	0.07 to 1.21
ICU stay >96 hours	87 (7%)	46 (5%)	41 (18%)	3.47	2.48 to 4.87
Postsurgical LOS ≥9 days	413 (34%)	306 (32%)	107 (47%)	1.79	1.38 to 2.32
Postoperative rehabilitation	897 (75%)	726 (75%)	171 (75%)	1.06	0.78 to 1.44

Data are median (interquartile range) or number (%).

mortality was low (2.8%), with clear cut differences with increasing EuroSCORE values. Actually, the death rate in the low risk group overlapped with data in the literature but it was definitely lower in the groups that scored 3–5 (1.1%) and ≥ 6 (6.2%).²

Table 3 Independent predictors of all cause mortality and combined end point by multivariate analysis

Predictor	Index score	HR	95% CI
All cause mortality			
EuroSCORE		1.55	1.03 to 2.34
D	0.045		
U	0.002		
Q	0.043		
Combined end point			
EuroSCORE		1.60	1.36 to 1.89
Number of co-morbidities			
≥2		1.49	1.09 to 2.02
0		0.67	0.46 to 0.99
1		1.00	NA
ICU stay >96 hours		2.04	1.42 to 2.95
D	0.033		
U	0.0002		
Q	0.033		

D, discrimination index; Q, overall quality index; U, unreliability index.

The main finding of the present study is that EuroSCORE had a similar predictive power even when applied to long term mortality and to a combined outcome of death or hospital admission for cardiovascular causes (fig 2). The risk increased for values over 4, a lower cut off than previously observed, for both mortality and the combined end point, whereas there was no significant decrement in risk for EuroSCORE below 2. This finding is consistent with data from the original derivation set and suggests that patients with a low EuroSCORE will have an uncomplicated long term as well as immediate postoperative course.

Toumpoulis and colleagues⁹ have recently reported that EuroSCORE is a significant predictor for long term mortality among CABG patients. Their study, as well as ours, was a retrospective assessment; however, it spanned a much longer time frame, when many changes have taken place in surgical techniques and postoperative care.

A prolonged postoperative ICU stay was the strongest predictor of long term outcome together with EuroSCORE. This finding expands previous results from our group,¹⁰ underscores the potential impact of surgery related complications on the subsequent course, and is consistent with long term quality of life assessment in cardiac surgery complicated by multiple organ failure.⁶

As Kurki and colleagues¹¹ previously showed, and in our series, in-hospital costs increased with EuroSCORE. Patients in higher risk groups had not only higher rates of

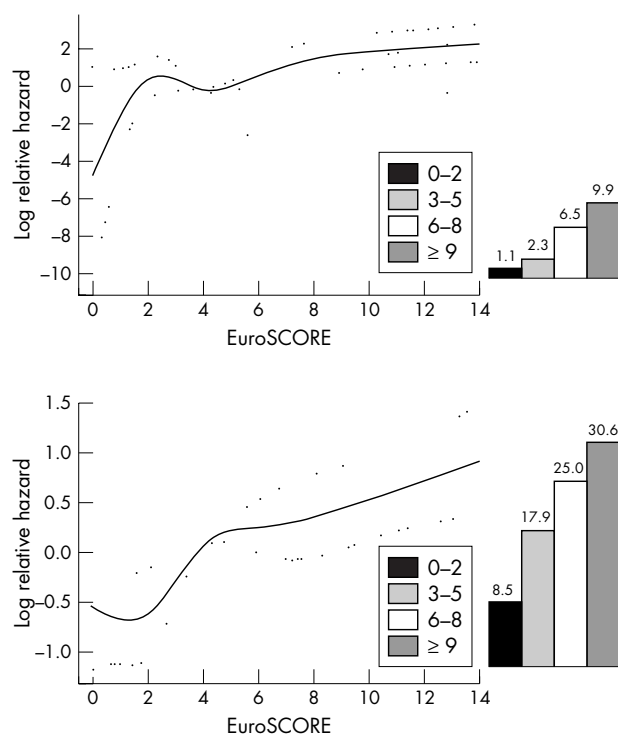


Figure 2 Logarithmic transformation of the hazard functions during follow up according to the EuroSCORE. Data for death after index discharge are presented in the upper panel and for death or hospital admission adjusted to co-morbidity and ICU length of stay in the lower panel. The corresponding crude long term death ($p < 0.0001$) or death and events rates ($p < 0.0001$) in the four EuroSCORE risk groups are shown in the right bottom corner of each graph.

cardiovascular events leading to hospital admission but also longer lengths of stay and higher DRG values. The costs roughly doubled from the low risk reference group to the very high risk patients.

Study limitations

Our study is a retrospective analysis of data from a single centre regional database and therefore our results should be extended with caution to the general population of patients undergoing cardiac surgery. We examined the impact of EuroSCORE in a selected series of patients undergoing mostly elective surgery and with generally preserved ventricular

function. However, more critical illness and depressed ventricular function would translate into higher EuroSCOREs and a greater proportion of high risk patients, which would probably reinforce these findings.

We examined all cause mortality and we could not ascertain the cause of death of patients who died out of hospital (14% of all deaths).

We used the simple additive EuroSCORE model and not the logistic one, which was shown to be more accurate for high risk patients.¹² However, it has been argued that, as the numbers of such patients are very small, for most cardiac surgical populations the discrepancy between the two models has little impact on risk prediction.¹²

Conclusions

Beyond prediction of operative survival, for which it was originally devised, EuroSCORE is a strong predictor of long term event-free survival and is associated with increased costs during follow up.

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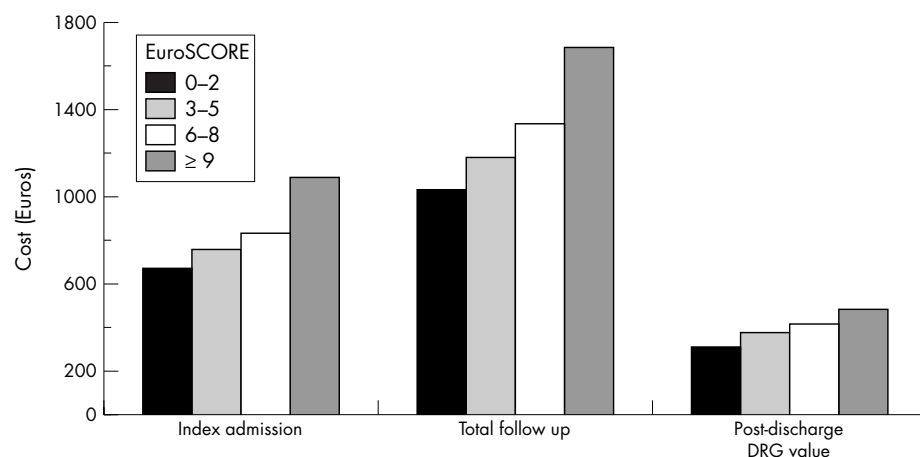


Figure 3 Median costs in Euros incurred for the index admission, for total follow up, and for the sum of post-discharge diagnosis related group (DRG) values according to EuroSCORE risk group.

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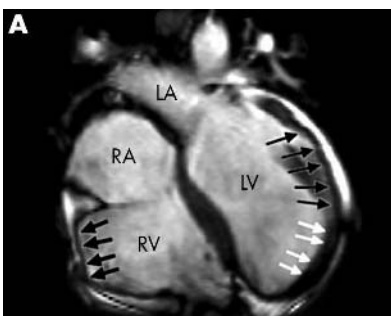
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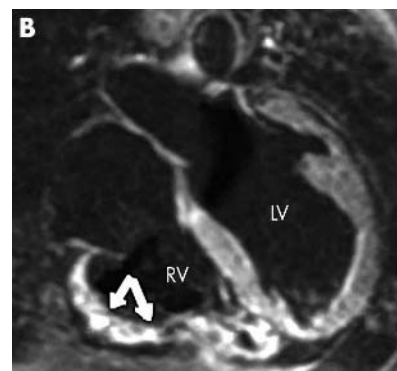
Arrhythmogenic right ventricular cardiomyopathy with fibrofatty atrophy, myocardial oedema, and aneurysmal dilation

A 43 year old man with known arrhythmogenic right ventricular cardiomyopathy (ARVC) was referred for a cardiovascular magnetic resonance (CMR) scan to assess disease progression. The diagnosis had been established 20 years earlier by right ventricular angiography. There was no evidence of coronary artery disease. He had previously suffered two cardiac arrests and declined intervention; recurrent ventricular tachycardia was eventually controlled by amiodarone treatment.

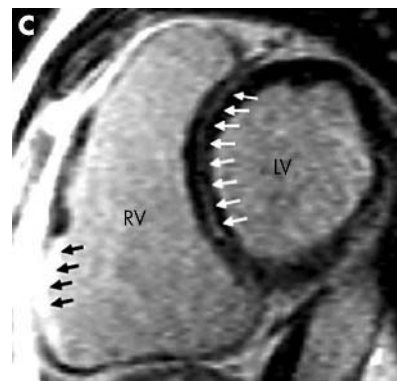
Characteristic pathological findings in ARVC include global and local dilation of the right ventricle, aneurysms, loss of myocardium, and replacement with adipose and fibrous tissue. Focal inflammatory infiltrates are also reported. Left ventricular involvement is common in advanced cases. Although CMR aims to identify these abnormalities in vivo, concomitant presence of all the hallmark morphological features in a single case is a rarity. Equally remarkable is the detection of fibrosis in both ventricles and myocardial oedema.



True FISP image. Four chamber view shows severe global enlargement of the right ventricle (RV) with localised dilation at the inflow tract (black arrows). The left ventricle (LV) is also moderately dilated. Regional thinning of the posterolateral LV wall is observed (black arrows). Normal LV wall thickness is highlighted by white arrows for comparison. LA, left atrium; RA, right atrium. To view video clip of left ventricular outflow tract, visit the *Heart* website—<http://www.heartjnl.com/supplemental>



T2 weighted spin echo image in the four chamber view with fat suppression. The bright areas within the grey myocardium (white arrows) are likely to represent oedema, suggesting the presence of patchy inflammatory infiltrates.



Following intravenous administration of gadolinium-DTPA, late enhancement was observed in both the right ventricle (RV) (black arrows) and the septum (white arrows). Since fat was absent from these regions on corresponding T1 weighted turbo spin images, the appearances are consistent with myocardial fibrosis. The mid-myocardial distribution is typical of fibrosis secondary to cardiomyopathy.

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